

# **Health Consultation**

**Exposure Investigation of Private  
Drinking Water Wells  
Walker and Lynx Creek area, Yavapai County, Arizona**

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**Prepared by**

**Arizona Department of Health Services  
Office of Environmental Health  
Environmental Health Consultation Services**

under cooperative agreement with the  
Agency for Toxic Substances and Disease Registry

## **Purpose**

In September 1999, the U.S. Environmental Protection Agency (EPA) Region 9 contacted the Arizona Department of Health Services (ADHS), Office of Environmental Health, concerning potential contamination of private drinking water wells along Lynx Creek in the Walker, Arizona, mining district. Historical mining activities in the area might have resulted in contamination of groundwater by acid mine runoff as well as metals from extraction processes. EPA and ADHS determined the historical mining activity had caused environmental damage and the potential for adverse human health impacts.

ADHS initiated a private well sampling program to determine if the mining activity has had an adverse impact on the quality of water from these wells. Several area residents have expressed concerns about their water quality.

The objective of this public health consultation is to evaluate the potential for health effects from exposure to contaminants in private drinking water wells in the Walker, Arizona area.

## **Background**

The Walker area is located approximately 10 miles southeast of Prescott, Arizona, in the Bradshaw Mountains. Lynx Creek and its unnamed tributaries form the main watershed of the area. The area is within the unincorporated boundaries of Yavapai County, and consists of a mixture of private and federally owned land. The Prescott National Forest surrounds the area, and the private properties are located on patented mining claims within the Prescott National Forest boundaries (B. Everson, staff geologist, Prescott National Forest Bradshaw Ranger Station, personal communication, July 1999).

The Walker Mining District was established in the 1860s after the discovery of gold and silver in the region. The area was heavily prospected, and since that time several larger mines and hundreds of smaller mines have been worked. The largest mine in the area, the Sheldon Mine, removed several hundred thousand tons of ore for processing over the course of its lifetime. Other smaller mines removed lesser amounts of materials. The overburden materials were often piled directly upon the properties or deposited in the most convenient place. Because of the topography, which consists of steep canyons with both annual and perennial streams at their bases, the mine wastes often ended up in these streams. Mine adits (horizontal shafts dug into the side of a hill) were often dug adjacent to these waters, with the waste rock ending up in the water (B. Everson, staff geologist, Prescott National Forest Bradshaw Ranger Station, personal communication, July 1999). Figure 1 displays the location of these landmarks and the approximate location of mining claim properties with private wells.

Because the homes built in the area are located on these mining claims, they are often built either upon or adjacent to both the mining ore and the processed waste materials. Due to the nature of the ore bodies in the district, other metals are often found. Metals such as arsenic, mercury, cadmium, antimony, and selenium are common metals within these types of ore bodies (California Environmental Protection Agency 1996).

Approximately 300 properties and mining claims are present in the Walker Mining District area. Most of the properties contain residences that consist of homes and/or mobile homes. A visual inspection of the area found that the occupied properties generally have private drinking water well sources. A few properties appear to share private drinking water sources. No water systems in the area have enough service connections to constitute a regulated drinking water system.

## **Methods**

Before sampling the water of the residents in the area, representatives of ADHS, EPA, the Arizona Department of Environmental Quality (ADEQ), and the U.S. Forest Service (USFS) formulated a plan on how to proceed with the various soil and water samplings. This plan called for a two-tiered approach, using human health and ecosystem damage as the criteria for further investigations. Since human health was of the most importance, the group suggested that ADHS assume the lead in this area.

ADHS staff conducted several site visits to determine the extent of community interest in a water quality investigation. Site visits included meetings with the Walker Fire Board, the primary community group for the area. At the meetings, several area residents expressed an interest in having their water sampled and analyzed. Serious health concerns regarding water quality were never expressed during the meetings.

ADHS offered the area residents free water testing for priority metals and sulfates because of the close proximity of the residences to known mine sites, and the possibility of shared groundwater sources. Because the properties use individual sewage disposal systems (septic tanks and leach fields), biological testing for fecal contamination was considered an important component of the sampling program.

ADEQ water quality specialists collected the water samples from the wells, and the ADHS State Laboratory analyzed the samples for priority metals and sulfate. Analyses for coliform bacteria were conducted to determine if levels of disease-causing bacteria were present in quantities that would warrant further analysis.

### *May 2000 Sampling Program*

In December 2000, ADHS posted a notification on the Walker Fire District bulletin board offering free water testing for area residents with private drinking water wells. Residents of 25 of

the approximately 300 properties responded to the request and asked for their water source to be tested.

In May 2000, ADEQ collected water samples from 20 private drinking water wells throughout the Walker area. Several samples indicated contaminant concentrations were in excess of EPA drinking water standards.

#### *April 2001 Sampling Program*

In February 2001, ADHS attempted to contact the residents who expressed interest in having their water sampled. During the April 2001 sampling event, a total of 10 wells were sampled. Analytical results were similar to the May 2000 results—several samples contained chemicals in excess of EPA drinking water standards.

In July 2000, ADHS met with the local Fire District Board to distribute the sampling results. ADHS also mailed well owners copies of their wells' analytical results and an explanation of the results.

## **Results**

A total of 30 wells were sampled in the Walker area. One well was sampled during both sampling events, resulting in a total of 31 samples.

Contaminants were selected for further toxicological evaluation if the constituent was found in at least one well in excess of the ATSDR chronic exposure comparison value for children. ATSDR chronic exposure comparison values are screening values used to determine whether further investigation of a contaminant is warranted. Concentrations of contaminants less than the comparison value are unlikely to pose a health threat.

The following table summarizes the analytical results. The contaminants selected for further evaluation are arsenic, cadmium, selenium, and sulfate.

Private Well Sampling Results, Walker Arizona

Contaminant	ATSDR Child Comparison Value (mg/L)	Frequency of Detection	Range (mg/L)	Frequency of Detection Above Comparison Value	Contaminant of Concern?
Metals					
Antimony	0.015*	3/31	ND-0.006	0/31	No
<b>Arsenic</b>	0.003	6/31	ND-0.058	6/31	<b>Yes</b>
Barium	0.7	5/31	ND-0.15	0/31	No
Beryllium	0.01	2/31	ND-0.0009	0/31	No
<b>Cadmium</b>	0.002	14/31	ND-0.13	13/31	<b>Yes</b>
Mercury	0.002	0/21	ND	0/21	No
Nickel	0.2	0/31	ND	0/31	No
<b>Selenium</b>	0.05	6/31	ND-0.089	1/31	<b>Yes</b>
Thallium	0.0005	0/31	ND	0/31	No
Non metals					
Cyanide	0.2	0/31	ND	0/21	No
<b>Sulfate</b>	250#	31/31	16-900	8/31	<b>Yes</b>

\* EPA Region 9 preliminary remediation goal. No ATSDR comparison value available.

# Secondary maximum contaminant level. No ATSDR comparison value available.

Overall, 17 of the 30 drinking water sources contained no contaminants of concern. Thirteen of the wells contained at least one contaminant in excess of the ATSDR chronic exposure comparison value for children. Two of the 21 samples taken in May 2000 were positive for total coliform bacteria, but not fecal coliform bacteria.

## Discussion

### *Exposure Quantification*

ADHS has made several assumptions regarding dose intake and assumptions used to quantify exposures. Professional judgment was used in estimating many of the variables using observations made at the site and using conversations with residents and members of the community and with staff from ADEQ.

Adults residing in the area are assumed to drink 2 liters of water per day for 30 years from their private wells. Children are assumed to drink 1 liter of water per day from the well throughout childhood, defined as 0–6 years of age. The dose calculations assume an adult body weight of

70 kilograms (kg) and a child bodyweight of 15 kg. The equations used to determine exposure can be found in the appendix.

### *Exposure Analysis*

ATSDR has developed a minimal risk level (MRL) for common contaminants to evaluate health effects from exposure to contaminants in water. The MRL is an estimate of daily human exposure to a contaminant below which noncancer, adverse health effects are unlikely to occur. MRLs are not used to determine the specific adverse health effects from exposure, rather they are used to determine if there is the need for a more thorough, contaminant-specific investigation. MRLs are developed for acute (less than 14 days), intermediate (14 to 365 days), and chronic (greater than 365 days) exposure.

A common misconception is that health guidance values such as MRLs represent a level above which toxicity is likely to occur. The MRL is neither a threshold for toxicity nor a level beyond which toxicity is likely to occur. MRLs are established solely as screening tools to determine whether further evaluation of the contaminant is warranted. This information is contained in documents known as toxicological profiles, published by ATSDR. These chemical-specific profiles provide information on health effects, environmental transport, human exposure, and regulatory status.

Additional evaluation is necessary to determine whether a health hazard exists when exposure estimates exceed MRLs. Literature sources are reviewed to determine what exposure doses are documented to actually cause a health problem. The no observed adverse effect level (NOAEL) is the exposure dose at which no effect was observed on the animal or human population in the study. The lowest observed adverse effect level (LOAEL) for a contaminant is the lowest exposure dose observed that results in a measurable adverse health effect in the animal or human population in the study. Whenever possible, NOAELs and LOAELs from studies in humans are reviewed when evaluating possible health effects as a result of exposure to the contaminant. However, if no human studies exist, studies on laboratory animals are reviewed, and the health assessor might include safety factors to address human differences when evaluating whether health effects might be possible.

The appendix displays childhood dose estimates. Exposure doses that exceed an MRL, NOAEL, or LOAEL are indicated in the last three columns. Remember that only a dose (not a chemical concentration) can exceed an MRL, NOAEL, or LOAEL.

### *Private Well Health Hazard Analysis*

ADHS calculated the estimated doses for each of the contaminants found in the wells that exceeded the ATSDR chronic childhood comparison values. Overall, 21 of the private wells contained no chemicals at a level of concern. Thirteen of the wells contained at least one contaminant in excess of the child comparison value. Only two of the wells contained total

coliform bacteria (Well 14 and 18). None of the wells contained fecal coliform bacteria, suggesting that bacterial water quality is generally good with no indications that pathogenic bacteria are present in any of the wells.

Estimated exposure doses to contaminants were compared to the chronic MRL, NOAEL, and LOAEL to evaluate the potential for adverse health effects for each contaminant. Each of the contaminants of concern was evaluated for its carcinogenic potential. Overall, 10 of the wells contained at least one contaminant at a concentration that might cause an adverse health effect. The following table displays these wells and contaminants:

**Wells and Contaminants of Health Concern**

<b>Well Number</b>	<b>Contaminants present that could harm children</b>	<b>Contaminants present that could harm adults</b>
2	Sulfate	Sulfate
8	Cadmium Sulfate	Sulfate
13	Arsenic	Arsenic
20	Selenium	Selenium
21	Arsenic Cadmium Sulfate	Arsenic Cadmium Sulfate
23	Cadmium Sulfate	Cadmium Sulfate
24	Arsenic Sulfate	Arsenic Sulfate
26	Arsenic	Arsenic
27	Arsenic Sulfate	Arsenic Sulfate
30	Cadmium	Cadmium

The following paragraphs discuss the contaminant levels for each of the wells that had at least one contaminant of concern.

**Well 2**

This well contained concentrations of cadmium and sulfate in excess of the ATSDR comparison values. The estimated doses for both contaminants exceeded the MRLs.

Estimated cadmium exposure doses for children are above the MRL, but more than 10 times

lower than the NOAEL for humans, suggesting that cadmium levels in this well do not pose a health threat (ATSDR 1999).

Estimated daily doses of sulfate in children and adults exceed the NOAEL and LOAEL. Because of the levels of sulfates in this well, infants whose formula was prepared using the water might experience some gastrointestinal upset and diarrhea. Other persons, including adults that are sensitive to sulfates, also might experience gastrointestinal upset and diarrhea (EPA 1999).

No other contaminants were detected that represent a health threat. None of the contaminants detected are thought to cause cancer.

ADHS recommends that this well not be used for drinking water or preparing beverages, including infant formula, due to elevated levels of sulfate. Other residential uses of water from this well pose no apparent health hazard.

### **Well 8**

This well contained concentrations of cadmium and sulfates in excess of the ATSDR comparison values. Child exposure doses for both cadmium and sulfate exceed the MRLs.

Estimated cadmium exposure doses for children are very close to the NOAEL, suggesting that cadmium might have the potential to pose a noncancer health hazard in sensitive persons (ATSDR 1999). Potential health effects might include subtle changes in kidney cells without affecting kidney function. Cadmium in drinking water has not been associated with the development of cancer.

Exposure doses based upon the estimated child dose to sulfates exceeded the NOAEL and LOAEL. Because of the levels of sulfates in this well, infants whose formula was prepared using the water might experience some gastrointestinal upset and diarrhea. Adult estimated doses are greater than the NOAEL and equal to the LOAEL, suggesting that adults who are sensitive to sulfates might also experience gastrointestinal upset and diarrhea (EPA 1999).

No other contaminants were detected that represent a health threat. None of the contaminants detected are thought to cause cancer from exposure in water.

ADHS recommends that this well not be used for drinking water or preparing beverages, including infant formula, due to elevated levels of sulfate and cadmium. Other residential uses of water from this well pose no apparent health hazard.

### **Well 12**

This well contained concentrations of cadmium in excess of the ATSDR comparison values. Exposure doses based upon the estimated daily dose for children and adults for cadmium were slightly lower than the MRLs. Estimated doses are more than 10 times lower than the NOAEL

for humans, suggesting that cadmium levels in this well do not pose a health threat. Cadmium in drinking water has not been associated with the development of cancer (ATSDR 1999).

No other contaminants were detected that represent a health threat. None of the contaminants detected are thought to cause cancer from exposure in water. Using this well for drinking water and other residential uses poses no apparent health hazard.

### **Well 13**

This well contained concentrations of arsenic and cadmium in excess of the ATSDR comparison values. Exposure doses based upon the estimated daily dose for children to both contaminants exceeded the MRLs.

Childhood estimates of exposure to arsenic at 0.0038 mg/kg/day exceed the NOAEL range of 0.0004 to 0.0009 mg/kg/day. The estimated dose is the same order of magnitude and is approximately the same as the LOAEL of 0.005 mg/kg/day. This suggests that exposure to arsenic present in this well might represent a health hazard for children such as changes in skin pigmentation. The adult estimated dose for arsenic of 0.001 mg/kg/day is close to the LOAEL but greater than the NOAEL, suggesting that arsenic in this well also might represent a health hazard for adults such as changes in skin pigmentation (ATSDR 2000).

Exposure to arsenic in drinking water has been reported to increase the risk of skin, liver, bladder, and kidney cancer. Studies suggest that these cancer effects might occur following long-term exposure. The concentration of arsenic in Well 13 was 58 µg/L, which is higher than the current drinking water standard of 50 µg/L and the 2006 standard of 10 µg/L. Lifetime exposure of arsenic at 58 µg/L in water would pose a cancer risk of less than 1 in 1,000.

Estimated cadmium exposure doses are 10 times lower than the NOAEL, suggesting that exposure to the contaminant does not pose a health hazard. Cadmium in drinking water has not been associated with the development of cancer (ATSDR 1999).

ADHS recommends that this well not be used for drinking water or preparing beverages, including infant formula, due to elevated levels of arsenic. Other residential uses of water from this well pose no apparent health hazard.

### **Well 14**

This well contained concentrations of cadmium in excess of the ATSDR comparison value, and the exposure dose estimate for cadmium exceeds the MRL. However, estimated cadmium exposure doses are 10 times lower than the NOAEL, suggesting that exposure to cadmium present in this well does not pose a noncancer health hazard. Cadmium in drinking water has not been associated with the development of cancer (ATSDR 1999).

No other contaminants were detected that represent a health threat. None of the contaminants

detected are thought to cause cancer from exposure in water.

Using this well for drinking water or other residential uses poses no apparent health hazard.

#### **Well 15**

This well contained concentrations of cadmium in excess of the ATSDR comparison values. Exposure doses based upon the estimated daily dose for children and adults for cadmium were slightly lower than the MRLs. Estimated doses are more than 10 times lower than the NOAEL for humans, suggesting that cadmium levels in this well do not pose a health threat. Cadmium in drinking water has not been associated with the development of cancer (ATSDR 1999).

No other contaminants were detected that represent a health threat. None of the contaminants detected are thought to cause cancer from exposure in water. Using this well for drinking water and other residential uses poses no apparent health hazard.

#### **Well 18**

This spring-type well contained total coliform bacteria suggesting that there might be bacterial contamination in the water. However, the water did not contain any fecal coliform bacteria. Total coliform tests are used as a general indicator of bacterial water quality, while fecal coliform tests determine whether human pathogens might be present in the water.

#### **Well 20**

This well contained concentrations of arsenic, cadmium, and selenium in excess of the ATSDR comparison value. Estimated doses to arsenic, cadmium, and selenium also exceeded the MRLs for these contaminants.

The childhood estimated exposure dose for arsenic of 0.0007 mg/kg/day is at the middle of the NOAEL range of 0.0004 to 0.0009 mg/kg/day. Estimated adult exposures are below the NOAEL range. A child's estimated dose of 0.0007 mg/kg/day is less than 10 times lower than the LOAEL of 0.005 mg/kg/day, suggesting that exposure to arsenic in this well does not pose a noncancer health hazard (ATSDR 2000). Long-term ingestion of arsenic is associated with development of cancer, primarily skin cancer. A slightly increased risk of developing cancer exists if this well water continues to be used for drinking water purposes.

This well contained concentrations of cadmium in excess of the ATSDR comparison values. Exposure doses based upon the estimated daily dose for children and adults for cadmium were slightly lower than the MRLs. Estimated doses are more than 10 times lower than the NOAEL for humans, suggesting that cadmium levels in this well do not pose a health threat. Cadmium in drinking water has not been associated with the development of cancer (ATSDR 1999).

The exposure dose estimate for selenium exceeds the MRL. The estimated selenium exposure dose of 0.0059 mg/kg/day is close to the NOAEL of 0.015 mg/kg/day, suggesting that selenium

might pose a noncancer health hazard. Health effects from selenium in drinking water can include brittle hair and deformed nails (ATSDR 1996).

No other contaminants were detected that represent a health threat.

ADHS recommends that this well not be used for drinking water or preparing beverages, including infant formula, because of elevated levels of selenium and arsenic. Other residential uses of water from this well pose no apparent health hazard.

### **Well 21**

This well contained arsenic, cadmium, and sulfates in excess of their ATSDR comparison values. Estimated exposure doses to antimony, arsenic, cadmium, and sulfate exceed MRLs.

The childhood estimated exposure dose for arsenic of 0.0009 mg/kg/day is at the maximum of the NOAEL range of 0.0004 to 0.0009 mg/kg/day. Estimated adult exposures are below the NOAEL range. A child's estimated dose of 0.0009 mg/kg/day is less than 10 times lower than the LOAEL of 0.005 mg/kg/day suggesting that exposure to arsenic in this well does not pose a noncancer health hazard (ATSDR 2000).

Exposure to arsenic in drinking water has been reported to increase the risk of skin, liver, bladder, and kidney cancer. Studies suggest that these cancer effects might occur following long-term exposure. The concentration of arsenic in Well 21 was 13 µg/L, which is lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure of arsenic at 13 µg/L in water would pose a cancer risk of less than 1 in 5,000.

The child estimated exposure dose of 0.009 mg/kg/day cadmium exceeds the LOAEL of 0.008 mg/kg/day. The LOAEL was established on the basis of a study that found renal tubule interstitial lesions in humans exposed to cadmium in drinking water at a dose of 0.008 mg/kg/day after 25 years of exposure. The adult estimated exposure dose to cadmium, 0.004 mg/kg/day, is approximately at the LOAEL of 0.008 mg/kg/day (ATSDR 1999).

Potential health effects might include subtle changes in kidney cells without affecting kidney function. Exposure to cadmium in drinking water has not been associated with the development of cancer.

Estimated sulfate exposure doses for adults and children exceed the LOAEL. Because of the levels of sulfates in this well, infants whose formula was prepared using the water might experience some gastrointestinal upset including diarrhea. Other persons, including adults that are sensitive to sulfates, might also experience gastrointestinal upset and diarrhea. Sulfate has not been associated with the development of cancer (EPA 1999).

ADHS recommends that this well not be used for drinking water or preparing beverages, including infant formula, because of elevated levels of sulfate, arsenic, and cadmium. Other residential uses of water from this well pose no apparent health hazard.

### **Well 23**

This well contained concentrations of cadmium and sulfates in excess of the ATSDR comparison values. Exposure doses based upon the estimated daily dose for children and adults to both contaminants exceeded the MRLs.

Estimated cadmium exposure doses for children are very close to the NOAEL, suggesting that cadmium might have the potential to pose a noncancer health hazard in sensitive persons. Potential health effects might include subtle changes in kidney cells without affecting kidney function. Cadmium in drinking water has not been associated with the development of cancer (ATSDR 1999).

Children and adult estimated exposure doses to sulfates exceed the NOAEL and LOAEL. Because of the levels of sulfates in this well, infants whose formula was prepared using the water might experience some gastrointestinal upset and diarrhea. Other persons, including adults who are sensitive to sulfates, might also experience gastrointestinal upset including diarrhea. Sulfate has not been associated with the development of cancer (EPA 1999).

No other contaminants were detected that represent a health threat. None of the contaminants detected are thought to cause cancer from exposure in water.

ADHS recommends that this well not be used for drinking water or preparing beverages, including infant formula, because of the elevated levels of cadmium and sulfate. Other residential uses of water from this well pose no apparent health hazard.

### **Well 24**

This well contained concentrations of arsenic, cadmium, and sulfate in excess of the ATSDR comparison value. Exposure doses to sulfate, arsenic, and cadmium also exceeded the MRLs for these contaminants.

A child's estimated exposure dose to arsenic of 0.002 mg/kg/day is approximately at the LOAEL of 0.005 mg/kg/day. That suggests that a child's exposure to arsenic in this well might pose a noncancer health hazard such as changes in skin pigmentation. The adult estimated dose for arsenic of 0.0008 is less than the LOAEL but is greater than the NOAEL, suggesting that arsenic in this well might also pose a noncancer health hazard for adults such as changes in skin pigmentation (ATSDR 2000).

Exposure to arsenic in drinking water has been reported to increase the risk of skin, liver, bladder, and kidney cancer. Studies suggest that these cancer effects might occur following long-term exposure. The concentration of arsenic in Well 24 was 28 µg/L, which is lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure of arsenic at 28 µg/L in water would pose a cancer risk of less than 1 in 3,000.

This well contained concentrations of cadmium in excess of the ATSDR comparison values. Exposure doses based upon the estimated daily dose for children and adults for cadmium were slightly lower than the MRLs. Estimated doses are more than 10 times lower than the NOAEL for humans, suggesting that cadmium levels in this well do not pose a health threat. Cadmium in drinking water has not been associated with the development of cancer (ATSDR 1999).

Exposure dose estimates for sulfates exceed the LOAEL. Because of the levels of sulfates in this well, infants whose formula was prepared using the water might experience some gastrointestinal upset and diarrhea. Estimated adult exposure doses are less than the NOAEL, suggesting that sulfate in this well does not pose a noncancer health hazard to adults. Sulfate has not been associated with the development of cancer (EPA 1999).

ADHS recommends that this well not be used for drinking water or preparing beverages, including infant formula, because of the elevated levels of sulfate and arsenic. Other residential uses of water from this well pose no apparent health hazard.

### **Well 26**

This well contained arsenic in excess of the ATSDR comparison values. Estimated exposure doses to arsenic exceed MRLs.

Exposure to arsenic in drinking water has been reported to increase the risk of skin, liver, bladder, and kidney cancer. Studies suggest that these cancer effects might occur following long-term exposure. The concentration of arsenic in Well 26 was 19 µg/L, which is lower than the current drinking water standard of 50 µg/L, but higher than the 2006 standard of 10 µg/L. Lifetime exposure of arsenic at 19 µg/L in water would pose a cancer risk of less than 1 in 3,000 (EPA 2000).

ADHS recommends that this well not be used for drinking water or preparing beverages, including infant formula, because of the elevated levels of arsenic. Other residential uses of water from this well pose no apparent health hazard.

### **Well 27**

This well contained concentrations of arsenic and sulfate in excess of the ATSDR comparison value. Estimated exposure doses to both contaminants also exceeded the MRLs.

A child's estimated exposure dose of arsenic is approximately that of the LOAEL of 0.005 mg/kg/day. However, the estimated exposure dose is sufficiently close to the LOAEL to suggest that a child exposed to arsenic from this well might represent a health hazard for children, such as changes in skin pigmentation. The adult estimated dose for arsenic of 0.001 is close to the LOAEL but greater than the NOAEL, suggesting that arsenic in this well also might represent a health hazard for adults, such as changes in skin pigmentation (ATSDR 2000).

Exposure to arsenic in drinking water has been reported to increase the risk of skin, liver, bladder, and kidney cancer. Studies suggest that these cancer effects might occur following long-term exposure. The concentration of arsenic in Well 27 was 58 µg/L, which is higher than the current drinking water standard of 50 µg/L and the 2006 standard of 10 µg/L. Lifetime exposure of arsenic at 58 µg/L in water would pose a cancer risk of less than 1 in 1,000.

This well contained concentrations of sulfate in excess of the comparison value. Exposure dose estimates based upon the estimated child dose also exceed the LOAEL. Because of the levels of sulfates in this well, infants whose formula was prepared using the water might experience some gastrointestinal upset and diarrhea. Estimated adult exposure doses are less than the NOAEL, suggesting that sulfate in this well does not pose a noncancer health hazard to adults. Exposure to sulfate has not been associated with the development of cancer (EPA 1999).

This well contained concentrations of cadmium in excess of the ATSDR comparison values. Exposure doses based upon the estimated daily dose for children and adults for cadmium were slightly lower than the MRLs. Estimated doses are more than 10 times lower than the NOAEL for humans, suggesting that cadmium levels in this well do not pose a health threat. Cadmium in drinking water has not been associated with the development of cancer (ATSDR 1999).

ADHS recommends that this well not be used for drinking water or preparing beverages, including infant formula, because of the elevated levels of sulfate and arsenic. Other residential uses of water from this well pose no apparent health hazard.

### **Well 30**

This well contained concentrations of cadmium in excess of the ATSDR comparison value. Cadmium exposure dose estimates exceed the MRL.

The estimated cadmium exposure dose for children of 0.002 mg/kg/day is approximately equal to the LOAEL of 0.008 mg/kg/day. These exposure estimates suggest that this well might present a noncancer health hazard to children because of the elevated cadmium levels. Potential health effects might include subtle changes in kidney cells without affecting kidney function. Exposure to cadmium in drinking water has not been associated with the development of cancer. Adult exposure estimates are less than half of the NOAEL, suggesting that cadmium does not pose a noncancer health hazard to adults (ATSDR 1999).

No other contaminants were detected that represent a health threat. None of the contaminants detected are thought to cause cancer from exposure in water.

ADHS recommends that this well not be used for drinking water or preparing beverages, including infant formula, because of the elevated levels of cadmium. Other residential uses of water from this well pose no apparent health hazard.

### **Child Health Initiative**

All exposure dose estimates were calculated assuming childhood exposure, which incorporates exposure assumptions that reflect children's greater intake of water relative to body weight. All conclusions in this report are based on these childhood exposure assumptions. Infants that might drink water containing elevated levels of sulfate are the most sensitive population in this study. All conclusions and recommendations about using water from wells were based on this most sensitive population.

### **Conclusions**

Ten of the 30 wells tested in 2000 and 2001 pose a **public health hazard** because contaminants are present in the wells at levels that could cause adverse health effects. The wells that **should not** be used for a drinking water supply are wells number 2, 8, 13, 20, 21, 23, 24, 26, 27, and 30. Other residential uses of water from these wells pose no apparent health hazard.

Twenty of the 30 wells pose no apparent public health hazard from the contaminants for which analyses were conducted.

Other private wells present in the area were not tested. Some of these wells could contain contaminants at levels that could cause adverse health effects.

### **Recommendations**

Residents of homes supplied drinking water from wells 2, 8, 13, 20, 21, 23, 24, 26, 27, and 30 should find an alternative source of drinking water.

All residents in the Walker area that use well water for drinking or beverage preparation should test their well water for sulfate, arsenic, and cadmium.

### **Public Health Action Plan**

ADHS has previously notified well owners whose wells were above the MCLs for metals and sulfates, as well as the bacteriological agents.

ADHS presented the general findings of the sampling program to the Walker Fire Board.

ADHS will notify the owners of all the wells that have been determined to be a health hazard in this report.

ADHS will place an advisory notice in the Walker Fire Board Newsletter with information on the findings of the investigation, along with recommendations to residents to have their well water analyzed for the contaminants found at concentrations above the MCLs. ADHS will also advise that wells be tested at least once per year for the bacteriological agents.

ADHS will coordinate with the University of Arizona Cooperative Extension Service to promote the water-testing program for rural counties in the Walker area.

ADHS staff will attend four Walker Community Fire Board meetings during 2002 to communicate the results of this consultation and to answer any additional questions that community members have.

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## Exposure Dose Equations

ADHS used the ATSDR exposure assessment documents to calculate an exposure dose for persons living in the Walker area. The doses were calculated using the following equations:

### *Ingestion of chemicals in water:*

$$\underline{CDI = CW \times IR \times EF \times ED}$$

$$\underline{BW \times AT}$$

CDI: chronic daily intake (ug/l/day)

CW: concentration in water (ug/L)

IR: intake rate (l/day)

EF: exposure frequency (days/yr)

ED: exposure duration (yrs)

BW: body weight (kg)

AT: Averaging time (days)

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Variable Assumptions	Adults	Children
IR (ingestion, water):	2	1
EF:	350	350
ED:	30	6
BW:	70	15
AT:	10950	2190

**Well Dose Estimates and Comparison Values\***

<b>. &amp; Contaminant of Concern</b>	<b>Child's Estimated Daily Dose (mg/kg/day)</b>	<b>Child Dose Exceeds MRL?</b>	<b>Child Dose Exceeds NOAEL?</b>	<b>Child Dose Exceeds LOAEL?</b>
<b>Well 2</b>				
Sulfate	51	Yes	Yes	Yes
Cadmium	0.0009	Yes	Yes	Yes
<b>Well 8</b>				
Sulfate	40	Yes	Yes	Yes
Cadmium	0.0016	Yes	Yes	Yes
<b>Well 12</b>				
Cadmium	0.0002	No	No	No
<b>Well 13</b>				
Arsenic	0.0038	Yes	Yes	Yes
Cadmium	0.00287	Yes	Yes	Yes
<b>Well 14</b>				
Cadmium	0.000433	Yes	No	No
<b>Well 15</b>				
Cadmium	0.000147	No	No	No
<b>Well 20</b>				
Arsenic	0.000667	Yes	No	No
Cadmium	0.000167	No	No	No
Selenium	0.000593	Yes	No	No
<b>Well 21</b>				
Arsenic	0.000867	Yes	Yes	No
Cadmium	0.008667	Yes	Yes	Yes
Sulfate	60	Yes	Yes	Yes
<b>Well 23</b>				
Cadmium	0.001333	Yes	Yes	No
Sulfate	18.666	Yes	Yes	Yes
<b>Well 24</b>				
Arsenic	0.001867	Yes	Yes	Yes
Cadmium	0.00014	No	No	No
Sulfate	19.333	Yes	Yes	Yes
<b>Well 26</b>				
Arsenic	0.001267	Yes	Yes	Yes
<b>Well 27</b>				
Arsenic	0.0003867	Yes	Yes	Yes

Cadmium	0.000147	No	No	No
Sulfate	24	Yes	Yes	Yes
<b>Well 30</b>				
Cadmium	0.002267	Yes	Yes	Yes

\* Well location map is in the appendix.